In addition, it is preferable to control the patterns of individual beams only when the communication amount of a beam with the largest communication amount exceeds a predetermined communication amount. Thus, the entire antenna can be simply controlled.

An adaptive antenna according to another embodiment of the present invention has a storing unit and an exciting weight information selecting means. The storing unit stores exciting weight information of each antenna element so as to accomplish the optimum pattern of each beam corresponding to the communication amount thereof. The exciting weight information selecting means selects relevant exciting weight information from the storing unit. With the adaptive antenna according to this embodiment, the optimum exciting weight can be set up by selecting relevant exciting weight information in the storing unit. Thus, the optimum exciting weight can be obtained more quickly than the system of which the beam width is switched in steps.

An adaptive antenna according to a further embodiment of the present invention has a storing unit and an exciting weight calculating means. The storing means stores information of optimum patterns corresponding to communication amounts of beams. The exiting weight calculating means calculates an exciting weight of which the difference between the pattern of each beam and a desired pattern becomes minimum. Thus, with the adaptive antenna according to this embodiment, the optimum exciting weights can be obtained more quickly than the system of which the beam widths are varied in steps. The stored information of the optimum patterns of beams corresponding to the communication amounts thereof can be freely varied corresponding to communication environments (communication amounts of individual beams that are unbalanced). Thus, the adaptive antenna can more flexibly handle various communication environments.

The calculated exciting weights may be varied in steps so as to obtain desired exciting weights. Thus, even if the patterns of sector beams are varied, a situation of which a communication of a user that is present in an angular area that the sector covers is disconnected is prevented as much as possible.

When a function for setting exciting weights of antenna elements and thereby placing a plurality of beams in the same shape is provided, a transmission load that concentrates in a particular area can be dispersed.

In addition, the number of sectors that have a prism shape and the number of antenna elements are not limited to those of the above-described embodiment. Moreover, exciting weights can be set up in a digital signal processing circuit that processes a digital signal on the base band.

Although the present invention has been shown and described with respect to best mode embodiments thereof, it should be understood by those skilled in the art that the foregoing and various other changes, omissions, and additions in the form and detail thereof may be made therein without departing from the spirit and scope of the present invention.

What is claimed is:

1. An adaptive antenna, comprising:
a plurality of antenna elements for forming a plurality of beams that cover a predetermined service area;
detecting means for detecting a communication amount of data transmitted or received with each of the beams; and
controlling means for controlling a direction and width of each of the beams corresponding to the detected communication amount.

2. The adaptive antenna as set forth in claim 1,
wherein said controlling means has beam pattern controlling means for controlling the direction and width of each of the beams corresponding to the detected communication amount so as to cause the communication amounts of the beams to be nearly matched.

3. The adaptive antenna as set forth in claim 1,
wherein said controlling means has means for controlling the direction and width of each of the beams when a maximum communication amount of each of the beams exceeds a predetermined value.

4. The adaptive antenna as set forth in claim 2,
wherein said beam pattern controlling means controls an exciting weight of each of the antenna elements so as to control the direction and width of each of the beam.

5. The adaptive antenna as set forth in claim 2,
wherein said beam pattern controlling means controls the width of at least a first beam and a second beam, the first beam having a maximum communication amount, the second beam having a minimum communication amount.

6. The adaptive antenna as set forth in claim 2,
wherein said beam pattern controlling means controls the width of at least a first beam and a second beam, the first beam having a maximum communication amount, the second beam having a minimum communication amount while keeping a sum of widths nearly constant.

7. The adaptive antenna as set forth in claim 4,
wherein said beam pattern controlling means has:
a weight information storing unit for storing exciting weight information of each of the antenna elements so as to accomplish optimum control of each of the beams corresponding to the communication amount of each of the beams; and
means for selecting relevant exciting weight information in said weight information storing unit.

8. The adaptive antenna as claimed in claim 4,
wherein said beam pattern controlling means has:
a pattern information storing unit for storing optimum direction and width information for each of the beams corresponding to the communication amount of each of the beams; and
means for calculating an exciting weight corresponding to a minimum difference between direction and width of each of the beams and the optimum direction and width information stored in said pattern information storing unit.

9. The adaptive antenna as set forth in claim 4,
wherein said beam pattern controlling means switches an exciting weight of each of said antenna elements in steps so as to control the direction and width of each of the beams.

10. An adaptive antenna, comprising:
a plurality of antenna elements for forming a plurality of beams that cover a predetermined service area;
detecting means for detecting for each of the beams a communication amount of data transmitted or received with each of the beams; and
controlling means for controlling a direction and width of each of the beams corresponding to the detected communication amount for each of the beams.

11. The adaptive antenna as set forth in claim 10,
wherein said controlling means has beam pattern controlling means for controlling the direction of each of the beams corresponding to the detected communication

amount so as to cause the communication amounts of the beams to be nearly matched.

12. The adaptive antenna as set forth in claim 10, wherein said controlling means has means for controlling the direction and width of each of the beams when a maximum communication amount of each of the beams exceeds a predetermined value.

13. The adaptive antenna as set forth in claim 11, wherein said beam pattern controlling means controls an exciting weight of each of the antenna elements so as to control the direction and width of each of the beam.

14. The adaptive antenna as set forth in claim 11, wherein said beam pattern controlling means controls the width of at least a first beam and a second beam, the first beam having a maximum communication amount, the second beam having a minimum communication amount.

15. The adaptive antenna as set forth in claim 11, wherein said beam pattern controlling means controls the width of at least a first beam and a second beam, the first beam having a maximum communication amount, the second beam having a minimum communication amount while keeping a sum of width nearly constant.

16. The adaptive antenna as set forth in claim 13, wherein said beam pattern controlling means has:

a weight information storing unit for storing exciting weight information of each of the antenna elements so as to accomplish optimum control of each of the beams corresponding to the communication amount of each of the beams; and

means for selecting relevant exciting weight information in said weight information storing unit.

17. The adaptive antenna as claimed in claim 13, wherein said beam pattern controlling means has:

a pattern information storing unit for storing optimum direction and width information for each of the beams corresponding to the communication amount of each of the beams; and

means for calculating an exciting weight corresponding to a minimum difference between direction and width of each of the beams and the optimum direction and width information stored in said pattern information storing unit.

18. The adaptive antenna as set forth in claim 13, wherein said beam pattern controlling means switches an exciting weight of each of said antenna elements in steps so as to control the direction and width of each of the beams.

19. An adaptive antenna, comprising:

a plurality of antenna elements for forming a plurality of beams that cover a predetermined service area;

a detector which detects a communication amount of data transmitted or received with each of the beams; and

a controller which controls a direction and width of plural of the beams in correspondence with the detected communication amount.

20. The adaptive antenna as set forth in claim 19, wherein the controller comprises:

a mechanism configured to determine that the communication amount transmitted or received with one of the beams exceeds a predetermined amount;

a mechanism configured to vary at least one of a direction and width of said one beam to reduce a coverage area of said one beam; and

a mechanism configured to vary at least one of a direction and width of at least one other beam to increase a coverage area of said at least one other beam.

21. A method of transmitting information to and from a base station within a predetermined service area covered by base station, comprising:

providing an adaptive antenna to communication to and from the base station;

forming a plurality of beams that cover the predetermined service area using said adaptive antenna;

detecting a communication amount of data transmitted or received with each of the beams; and

controlling a direction and width of plural of the beams in correspondence with the detected communication amount.

22. The method as set forth in claim 21, wherein the controlling step comprises:

determining that the communication amount transmitted or received with one of the beams exceeds a predetermined amount;

varying at least one of a direction and width of said one beam to reduce a coverage area of said one beam; and

varying at least one of a direction and width of another beam to increase a coverage area of said another beam.